DECLARATION

I, Akiko Shishido, of SHIGA INTERNATIONAL PATENT OFFICE, 2-3-1, Yaesu, Chuo-ku, Tokyo, Japan, understand both English and Japanese, am the translator of the English document attached, and do hereby declare and state that the attached English document contains an accurate translation of the official certified copy of Japanese Patent Application Nos.H11-90146 and H11-29362 and that all statements made herein are true to the best of my knowledge.

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[Title of the Invention] PRINTING PLATE MATERIAL AND METHOD FOR PREPARATION AND RENEWAL THEREOF

[Claims]

[Claim 1] A printing plate material comprising mainly a substrate on the surface of which a coat layer containing a titanium oxide photocatalyst is formed directly or with an intermediate layer intervening, wherein

the coat layer has a surface wherein at least one part of which has a part converted into a hydrophilic surface by irradiation with light having a wavelength at an energy level higher than a band gap energy of a titanium oxide catalyst and a hydrophobic part which is not irradiated with the light, where

the surface of the coat layer when subjected to light irradiation thereon and/or an electrochemical treatment thereon is hydrophobic.

[Claim 2] The printing plate material as recited in claim 1, wherein the surface of said coat layer has hydrophobicity in terms of a water contact angle of at least 50° or more in its initial state.

[Claim 3] The printing plate material as recited in claim 1 or claim 2, wherein the surface of said coat layer has hydrophobicity in terms of a water contact angle of at least 50° or more in its initial state and is converted into a hydrophilic surface having a water contact angle of 10° or less by irradiation with light having a wavelength at an energy level higher than a band gap energy level of the titanium oxide photocatalyst, and wherein the hydrophilic surface serves as a non-printing image portion and the remaining hydrophobic surface serves as a printing image portion.

[Claim 4] The printing plate material as recited in any of claims 1 to 3, wherein the surface of said coat layer being hydrophilic in at least one portion thereof is reconverted into a hydrophobic surface having a water contact angle of at least 50° or more by light irradiation thereon and/or an electrochemical treatment thereon.

[Claim 5] The printing plate material as recited in any of claims 1 to 4, wherein the surface of said coat layer being hydrophilic in at least one portion thereof is reconverted into a hydrophobic surface having a water contact angle of at least 50° or more by cleaning the surface and renewing the surface of the coat layer containing the titanium oxide catalyst to renew the catalyst.

[Claim 6] A method for renewing a printing plate material, the printing plate

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[Title of the Invention] PRINTING PLATE MATERIAL AND METHOD FOR PREPARATION AND RENEWAL THEREOF

[Claims]

[Claim 1] A printing plate material comprising mainly a substrate on the surface of which a coat layer containing a titanium oxide photocatalyst is formed directly or with an intermediate layer intervening, wherein

the coat layer has a surface wherein at least one part of which has a part converted into a hydrophilic surface by irradiation with light having a wavelength at an energy level higher than a band gap energy of a titanium oxide catalyst and a hydrophobic part which is not irradiated with the light, where

the surface of the coat layer when subjected to light irradiation thereon and/or an electrochemical treatment thereon is hydrophobic.

[Claim 2] The printing plate material as recited in claim 1, wherein the surface of said coat layer has hydrophobicity in terms of a water contact angle of at least 50° or more in its initial state.

[Claim 3] The printing plate material as recited in claim 1 or claim 2, wherein the surface of said coat layer has hydrophobicity in terms of a water contact angle of at least 50° or more in its initial state and is converted into a hydrophilic surface having a water contact angle of 10° or less by irradiation with light having a wavelength at an energy level higher than a band gap energy level of the titanium oxide photocatalyst, and wherein the hydrophilic surface serves as a non-printing image portion and the remaining hydrophobic surface serves as a printing image portion.

[Claim 4] The printing plate material as recited in any of claims 1 to 3, wherein the surface of said coat layer being hydrophilic in at least one portion thereof is reconverted into a hydrophobic surface having a water contact angle of at least 50° or more by light irradiation thereon and/or an electrochemical treatment thereon.

[Claim 5] The printing plate material as recited in any of claims 1 to 4, wherein the surface of said coat layer being hydrophilic in at least one portion thereof is reconverted into a hydrophobic surface having a water contact angle of at least 50° or more by cleaning the surface and renewing the surface of the coat layer containing the titanium oxide catalyst to renew the catalyst.

[Claim 6] A method for renewing a printing plate material, the printing plate

material comprising a substrate on the surface of which a coat layer containing a titanium oxide photocatalyst is formed directly or with an intermediate layer intervening, the method comprising at least the steps of:

cleaning a surface of the coat layer containing a titanium oxide photocatalyst after completion of printing having used hydrophobic ink; and then

renewing the coat layer containing a titanium oxide photocatalyst by irradiation of light thereon and/or an electrochemical treatment.

[Claim 7] A method for preparing and renewing a printing plate material as recited in any of claims 1 to 5, wherein processes related to preparation and restoration of a printing plate are performed in a printing machine.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a printing plate material and to a method for preparation and renewal thereof.

[0002]

[Prior Art]

In the field of printing technology in general, digitization of printing process has recently been advancing. This technology involves creation of images and documents or manuscripts in digitized form on a personal computer or reading images on a scanner to digitize the image data and directly making a printing plate based on the digital data thus obtained. This allows labor-saving in the whole printing process and facilitates high definition printing.

[0003]

Hitherto, there has been generally used as a plate for use in printing a so-called PS plate which has anodized aluminum as a hydrophilic non-image part and a hydrophobic image part formed by curing a light-sensitive resin on a surface of the non-image part. To prepare a printing plate using the PS plate, a plurality of steps are necessary so that making of plates takes a long time and incurs high costs. Therefore, currently it is difficult to promote a reduction in time of printing processes and a reduction in cost of printing. In particular, this is the major factor of an increase in printing costs in the case of making a small number of prints.

[0004]

When the printing of one picture pattern is completed, the plate has to be exchanged by a new one before the next printing can be performed and the used plates have been disposed of. Further, with PS plates, it is impossible to directly make printing plates based on digital data and the making of printing plates is a hindrance to the progress of digitization of printing processes in order to achieve labor-saving or high definition printing.

[0005]

[Problems to be Solved by the Invention]

To obviate the above disadvantages with PS plates, several methods have been proposed to facilitate preparation of printing plates in accordance with the digitization of printing process, and some of them have been commercialized. For example, there are known methods which comprise providing a PET film having coated thereon a laser absorbing layer such as a carbon black layer and a silicone resin layer in order and imagewise irradiating the film with laser light to generate heat in the laser absorbing layer to burn off the silicone resin layer by the heat to prepare a printing plate, methods which comprise coating an oleophilic laser absorbing layer onto an aluminum plate and a hydrophilic layer onto the oleophilic laser absorbing layer and irradiating the hydrophilic layer with laser light to burn it off to make a printing plate, and the like. Although these methods allow preparation of printing plates directly based on digital data, in these methods, when the printing of one picture pattern is over, the printing plate must be exchanged by a new one before the next printing can be performed. Therefore, printing plates once used must be disposed of and in this regard, the above methods are the same as the method which uses the PS plate.

[0006]

The present invention was completed in consideration of the abovementioned circumstances; thus, objects thereof are the provision of printing plate material which can be recycled along and be compatible with digitalization of printing processes, and to provide production and renewal methods therefor.

[0007]

[Means for Solving the Problems]

The present invention comprises the following means for solving the abovementioned problems.

That is, the printing plate material recited in claim 1 comprises mainly a substrate

on the surface of which a coat layer containing a titanium oxide photocatalyst is formed directly or with an intermediate layer intervening, wherein the coat layer has a surface wherein at least one part of which has a part converted into a hydrophilic surface by irradiation with light having a wavelength at an energy level higher than a band gap energy of a titanium oxide catalyst and a hydrophobic part which is not irradiated with the light, where the surface of the coat layer when subjected to light irradiation thereon and/or an electrochemical treatment thereon is hydrophobic.

[0008]

According to this printing plate material, upon irradiation of a surface of the coat layer having hydrophobicity with light, those portions of the printing plate material of the invention irradiated can become hydrophilic. This is attributable to the effect of the titanium oxide photocatalyst. Utilization of the portions which have become hydrophilic as a non-printing image portion to which no ink will adhere and the remaining hydrophobic portion as a printing image portion to which ink will adhere allows the material to exhibit its function as a printing plate material. The printing plate material has a least one part which is hydrophilic within the surface of the printing plate material, and when the remaining part is subjected to light irradiation or an electrochemical process, or a combination of light irradiation and an electrochemical process, on the coat layer surface which is hydrophobic, the entire coat layer surface can thereby be converted into a hydrophobic surface. The effect of conversion from hydrophilicity to hydrophobicity by light irradiation or electrochemical treatment is a new effect discovered by the present inventors.

In the case where an intermediate layer is provided as needed between the substrate and the coat layer, the adhesion strength of the coat layer can be maintained at a sufficient level.

[0009]

The printing plate material as recited in claim 2 is one, wherein the surface of said coat layer has hydrophobicity in terms of a water contact angle of at least 50° or more in its initial state. Accordingly, in the initial state during preparation of a plate, the entire surface of the plate can become an image portion.

[0010]

The printing plate material as recited in claim 3 is one wherein the surface of said coat layer has hydrophobicity in terms of a water contact angle of at least 50° or more in

its initial state and is converted into a hydrophilic surface having a water contact angle of 10° or less by irradiation with light having a wavelength at an energy level higher than a band gap energy level of the titanium oxide photocatalyst, and wherein the hydrophilic surface serves as a non-printing image portion and the remaining hydrophobic surface serves as a printing image portion.

[0011]

With this construction, a printing plate can be prepared by writing a non-printing image portion on the hydrophobic surface of the coat layer having the function of a printing image portion with the above-described light, so that it can be said to be adaptable to the digitization of the printing process. In the present invention, the process of writing an image with light is hereinafter termed "a preparation of printing plate material".

[0012]

The printing plate material as recited in claim 4 is one wherein the surface of said coat layer being hydrophilic in at least one portion thereof is reconverted into a hydrophobic surface having a water contact angle of at least 50° or more by light irradiation thereon and/or an electrochemical treatment thereon.

[0013]

With this construction, the surface of the coat layer which contains a portion which is hydrophilic becomes hydrophobic by irradiation with light carrying out an electrochemical treatment or carrying out a combination of the irradiation of light and electrochemical treatment. Then, the printing plate material can be considered to have become one equivalent to the printing plate material of claim 2, i.e., the printing plate material is in an initial state again. This means that the printing plate materials can be recycled.

[0014]

The printing plate material as recited in claim 5 is one, wherein the surface of said coat layer being hydrophilic in at least one portion thereof is reconverted into a hydrophobic surface having a water contact angle of at least 50° or more by cleaning the surface and renewing the surface of the coat layer containing the titanium oxide catalyst.

[0015]

With this construction, the entire surface of the printing plate has hydrophobicity. That is, there emerges an initial state where all the surface constitutes a non-printing image portion. In short, the printing plate material can be recycled. In the present

invention, the step of uniformly rendering hydrophobic the entire surface of a coat layer containing the titanium oxide photocatalyst, this surface being hydrophilic in at least one portion thereof and hydrophobic in the remainder, is generally referred to as renewal of a printing plate material.

[0016]

The method for renewing a printing plate material as recited in claim 6 is one in which the printing plate material comprising a substrate on the surface of which a coat layer containing a titanium oxide photocatalyst is formed directly or with an intermediate layer intervening, the method comprising at least the steps of cleaning a surface of the coat layer containing a titanium oxide photocatalyst after completion of printing having used hydrophobic ink; and then renewing the coat layer containing a titanium oxide photocatalyst by irradiation of light thereon and/or an electrochemical treatment. Accordingly, it is clear that preparation and renewal of a plate can occur repeatedly.

[0017]

The method for preparing and renewing a printing plate material as recited in claim 7 is one of claims 1 to 5 wherein a process related to preparation and restoration of a printing plate is performed in a printing machine. Accordingly, there is no discontinuation of printing, and continuous printing operations can be effectuated without a sandwiching of printing plate replacement operations.

[0018]

[Embodiments of the Invention]

Hereafter, embodiments of the present invention will be described with reference to the attached drawings. Fig. 1 is a cross-sectional view showing the printing plate material according to the present embodiment. In Fig. 1, a substrate 1 is composed of aluminum. To use aluminum as a printing plate material is a common mode but the present invention is not limited thereto.

[0019]

An intermediate layer 2 is formed on the surface of the substrate 1. The material which can be used for the intermediate layer 2 includes, for example, silicon based compounds such as silica (SiO_2), silicone resins, and silicone rubbers. Of these, in particular, there are used silicone resins such as silicone alkyd, silicone urethane, silicone epoxy, silicone acrylic, and silicone polyester. The intermediate layer 2 is formed in order to ensure attachment of and secure the adhesion of the substrate 1 and a coat layer 3

described hereinbelow.

[0020]

The coat layer 3, which contains a titanium oxide photocatalyst is formed on the intermediate layer 2. The surface of the coat layer 3 is hydrophobic in an initial state of the printing plate as prepared, and a portion which is hydrophilic emerges by irradiating the portion with ultraviolet rays. This property is attributable to the property of the above titanium oxide photocatalyst. This will be explained in detail later on.

[0021]

In addition, the coat layer 3 may contain one or more of the following substances in order to improve the property of conversion from hydrophilicity to hydrophobicity or to increase the strength of the coat layer 3 or the adhesion of it to the substrate 1. Examples of the substances include silica based compounds such as silica, silica sol, organosilane, and silicone resin, metal oxides or metal hydroxides containing a metal such as zirconium or aluminum, fluorine-containing resins.

[0022]

Titanium oxide photocatalysts per se includes anatase types and rutile types having different crystal structures, respectively, and a mixture of both may be used. To enable high definition printing by increasing the resolution of the image to be written on a printing plate, and to enable the formation of the coat layer 3 in a small thickness, the titanium oxide photocatalyst preferably has a particle diameter of 0.1 μm or less.

[0023]

As for the titanium oxide photocatalyst, specific examples thereof which are commercially available and can be used in the present embodiment include ST-01, ST-21, their processed products ST-K01 and ST-K03, water dispersed type STS-01, STS-02 and STS-21, all produced by Ishihara Sangyo Kaisha, Ltd.; SSP-25, SSP-20, SSP-M, CSB, and CSB-M, and paint type LAC TI-01, produced by Sakai Chemical Industry Co., Ltd.; ATM-600, and ST-157 produced by TAYCA Corporation. However, it is needless to say that the present invention can be practiced with titanium oxide photocatalysts other than the above.

[0024]

It is preferred that the coat layer 3 have a thickness in the range of 0.01 to 10 μm. This is because too small a film thickness makes it difficult to utilize the above-described properties sufficiently whereas too large a film thickness tends to lead to cracking of the

coat layer 3, thereby causing a decrease in durability. The cracking is observed remarkably when the film thickness exceeds 20 μm so that it is necessary to note that an upper limit of the film thickness is 20 μm if the above range is to be realized. In a general mode, in practice, the film thickness is on the order of 0.1 to 3 μm.

[0025]

As the method for forming the coat layer 3, the renewal of the coat layer 3 is practiced by using a sol coating method, organic titanate method, vapor deposition method or the like as appropriate. In this case, for example, when a coating method is adopted, in addition to titanium oxide catalysts and the abovementioned substances for improving the strength of the coat layer 3 and the adhesiveness of substrate 1, the coating liquid used therein may contain solvents, crosslinking agents, surfactants, etc. The coating liquid may be either of a room temperature drying type or of a heat drying type. It is more preferable to adopt the latter since it is more advantageous for increasing the durability of printing plate to increase the strength of the coat layer 3 by heating.

[0026]

Hereafter, the operation and effect of the printing plate material having the above construction will be described. First, in an initial state of the printing plate material as prepared, the surface of the coat layer 3 is adjusted to have hydrophobicity in terms of a water contact angle of at least 50° as shown in Fig. 1. In this connection, a more preferred state may be obtained by adjustment such that the above contact angle is 80° or more. In this state, as can be seen from Fig. 1, it is difficult for water to adhere to the surface of the coat layer 3, that is, the surface of the coat layer 3 is in a state where its water repellency is very high. Expressing it the other way around, it can be said that there emerges a state where a printing ink can readily adhere to the surface of the coat layer 3.

[0027]

The expression "an initial state of the printing plate material as prepared" can be interpreted as meaning the time of initiation in an actual printing process. More specifically, it indicates a state where, for any given image, digitized data thereof are already provided and an image from the data is being written onto the printing plate material.

[0028]

Next, the surface of the coat layer 3 in the above state is irradiated with

ultraviolet rays as shown in Fig. 2. The irradiation with ultraviolet rays is performed in accordance with digital data on the above-described image and so as to correspond to the data. The ultraviolet rays as used herein refer to light having a wavelength having an energy higher than the band gap energy of the titanium oxide photocatalyst, more specifically, ultraviolet rays containing light having a wavelength of 400 nm or less.

[0029]

Upon irradiation with the ultraviolet rays, the surface of the coat layer 3 becomes hydrophilic as shown in Fig. 2. This is attributable to the effect of the titanium oxide photocatalyst. As a result, the region irradiated with ultraviolet rays is in a state where its water contact angle is 10° or less. This state is just in a relationship opposite to the state of the hydrophobic surface earlier described. That is, water spreads on the surface of the coat layer 3 almost in the form of a film but it is impossible for printing inks to adhere to the surface.

[0030]

The method for generating the hydrophilic portion based on the above image can be practiced without difficulty since it is only necessary to control the region which is irradiated with ultraviolet rays based on the above digital data of the image concerned. That is, unlike the conventional PS plates whose hydrophobic portion is formed by hardening a photosensitive resin, it can be said that the printing plate material of the present embodiment is adaptable to the digitization of printing process without difficulty.

[0031]

In this connection, the mechanism in which the titanium oxide photocatalyst is rendered hydrophilic by irradiation with ultraviolet rays is roughly presumed as follows. When the titanium oxide photocatalyst is hydrophobic, oxygen O^{2-} is bonded in the form of a bridge between Ti^{4+} ions on the surface thereof as shown in Fig. 3(a). Upon irradiation of this with ultraviolet rays, the bridge-like O^{2-} is converted to an O atom, which is eliminated from the surface and the two electrons released from the eliminated O^{2-} reduce two adjacent Ti^{4+} to form (Ti^{3+})s as shown in Fig. 3(b). Then, in Fig. 3(b), water molecules in the air are adsorbed onto the oxygen deficient portion and thereby a layer of hydroxyl groups is formed on the surface of the coat layer, resulting in hydrophilicity (Fig. 3(c)(d)). Moreover, the state of being coated with hydroxyl groups is a metastable state, and in a state in which ultraviolet rays are not irradiated, for example, by leaving in a dark place, there is a gradual shift to a hydrophobic surface having a steady

state.

[0032]

When the treatment thus far is over, a hydrophobic printing ink is coated onto the surface of the coat layer 3. Then, for example, a printing plate material as shown in Fig. 4 is prepared. In Fig. 4, the hatched portion is a portion where the above hydrophilization treatment has not been performed, that is, the hydrophobic portion, and hence indicates a printing image portion 4 where hydrophobic ink is adhered. The remaining background portion, that is, the hydrophilic portion, repels the hydrophobic ink and hence indicates a non-printing image portion 5 where no adhesion of the printing ink has occurred. Emergence of a picture pattern in this manner allows the surface of the coat layer 3 to function as a plate for printing. Moreover, when hydrophobic printing ink is coated onto the surface of coat layer 3, it goes without saying that the ink and moistening water may be coated in a mixed state. Thereafter, a usual printing process is practiced and completed.

[0033]

Next, the step of renewing the printing plate material will be explained. First the coat layer 3 after completion of the printing is wiped to remove the ink, dampening water, paper dust, etc., from the surface of the coat layer 3. Thereafter, the surface of the coat layer 3 is dipped into an aqueous electrolyte solution and voltage is applied to the substrate 1. In this case, simultaneously with the application of voltage, the surface of the coat layer 3 may be irradiated with ultraviolet rays. Practice of such an electrochemical treatment renders the entire surface of the coat layer 3 hydrophobic and reversed to the "initial state of the printing plate material as prepared". On this surface, irradiation with ultraviolet rays again enables preparation of a new printing plate. In short, the printing plate material of the present embodiment allows for its recycling, in other words repeated use.

[0034]

As described earlier, a hydrophilic surface which is inherently metastable tends to slowly shift to a hydrophobic surface, which is in a stable state. However, it is presumed that the electrochemical treatment according to the present invention described above accelerates the reaction of converting Ti^{3+} to Ti^{4+} to thereby reduce the time required for hydrophobization considerably.

[0035]

Fig. 5 is a graph illustrating what has been explained above. This is a graph plotting time (or operation) in the horizontal axis vs. water contact angle in the vertical axis, illustrating the change in water contact angle (i.e., a hydrophobic state or a hydrophilic state) concerning a certain point on the surface of the coat layer 3 with the passage of time.

[0036]

According to this graph, first the surface of the original coat layer 3 has high hydrophobicity in terms of a water contact angle of 80° or more, which is the "initial state of the printing plate material as prepared" (point A in Fig. 5). Thereafter, irradiation with ultraviolet rays is performed to convert at least one portion of the surface of the coat layer 3 to a hydrophilic non-printing image portion with the ultraviolet non-irradiated portion remaining to be a hydrophobic printing image portion, thereby forming a printing plate material. Then, printing is performed as indicated by the straight line C in Fig. 5. After completion of the printing, the adhering matter and dirt on the surface of the coat layer 3 were cleaned and the surface of the coat layer 3 was rendered hydrophobic again by the electrochemical treatment described above (point A' in Fig. 5), that is, reverted to the "initial state of the printing plate material as prepared" and the printing plate is recycled.

[0037]

As described immediately above, the printing plate material of the present embodiment has an advantage that it can be recycled and in addition another advantage that its cycle can be speeded up. That is, according to the above advantages, no excessive time is necessary for realization of imparting either hydrophobicity or hydrophilicity. Therefore, the whole printing process can be completed very quickly.

[0038]

Hereafter, a more specific example relating to preparation and printing of a printing plate material, which the present inventors have confirmed, will be described.

First, a substrate made of aluminum having a size of a post card and a thickness of 0.3 mm was provided. On this, a primer, LAC PR-01 manufactured by Sakai Chemical Industry Co., Ltd., was coated and dried. After the drying, the thickness of the primer layer was 0.8 μm. The primer layer corresponds to the intermediate layer 2 in Fig. 1. Thereafter, a titanium oxide photocatalyst coating agent LAC TI-01 manufactured by Sakai Chemical Industry Co., Ltd. was coated thereon and dried at 100°C to form the coat layer 3 having a thickness of 0.7 μm. The water contact angle of the coat layer 3 of this

printing plate material was measured using a CA-W type contact angle meter manufactured by Kyowa Kaimen Kagaku Co., Ltd., and a water contact angle of 84° was obtained, thus exhibiting hydrophobicity sufficient for use as a printing image portion. It was confirmed that the printing plate was returned to its initial state as prepared.

[0039]

Next, the central part of the printing plate material was masked by black paper in the form of a square 2 cm long on each side. The unmasked portion was irradiated with ultraviolet rays at an illuminance of 40 mW/cm^2 for 1 minute and immediately thereafter, the water contact angle of the ultraviolet irradiated portion was measured using a CA-W type contact angle meter to obtain water contact angle of the ultraviolet irradiated portion of 6°. Thus the ultraviolet irradiated portion exhibits hydrophilicity sufficient for use as a non-printing image portion. The printing plate material was set onto a DX type card printing machine of SAN OFF-SET 220E manufactured by SAN PRINTING MACHINES CO. Printing was performed on AIBESUTO paper with an HYECOO B Red MZ ink manufactured by Toyo Ink Manufacturing Co., Ltd. and dampening water, a 1% solution of LITHOFELLOW manufactured by Mitsubishi Heavy Industries, Ltd., and at a printing speed of 2500 sheets/hour. As a result, no ink adhered to the ultraviolet irradiated portion of the surface of the printing plate material while a red image in the form of a square having a length of 2 cm on each side corresponding to the surface of masked portion was printed on the paper.

[0040]

Subsequently, an example relating to the renewal of printing plate material will be explained. First, a printing plate material from which the ink and dampening water adhered to the surface thereof were wiped off was dipped in an aqueous $NaSO_4$ solution (concentration 0.1 M). A lead wire was connected to the substrate of the printing plate and the printing plate was irradiated with ultraviolet rays while a voltage of +0.5 V was applied to the substrate. Immediately thereafter, the printing plate material was measured for a water contact angle at several points selected from over the whole surface using a CA-W type contact angle meter to obtain a water contact angle of 80 to 82°, thus exhibiting hydrophobicity sufficient for use as a printing image portion. It was confirmed that the printing plate material was in the initial state of the printing plate material as prepared.

[0041]

The printing was performed using a printing machine 10 as shown in Fig. 6. Specifically, the printing machine 10 comprises a plate cleaning apparatus 12 (cleaning apparatus), an electrochemical treating apparatus 13, a writing apparatus 14, an inking roller 15, and a blanket cylinder 16 around a plate cylinder 11 in the center. The printing plate material is arranged wound around the plate cylinder 11.

[0042]

In the printing machine 10, the renewal process of the printing plate material after completion of the printing is performed as follows. First, the plate cleaning apparatus 12 is brought into contact with the plate cylinder 11 and the ink and dampening water adhered to the outermost surface of the printing plate are wiped off. Thereafter, the plate cleaning apparatus 12 is released from the plate cylinder 11 and the electrochemical treating apparatus 13 is brought closer to the plate cylinder 11 so that a clearance between a transparent electrode 131 and the plate cylinder 11 is on the order of 100 to 200 μm. By so doing, the printing plate material is subjected to the hydrophobization treatment as described above and is renewed to revert to the initial state of the printing plate material as prepared. On this occasion, onto the surface of the printing plate material on the plate cylinder 11 is supplied an electrolyte solution (aqueous $NaSO_4$ solution in the above embodiment) 132 through an electrolyte solution supply nozzle 133. The transparent electrode 131 and the plate cylinder 11 are connected to power source 134.

[0043]

Thereafter, the electrochemical treating apparatus 13 is released from the plate cylinder 11, and an image is written on the renewed surface of the coat layer 3 with ultraviolet rays emitted by the writing apparatus 14 based on the digital data on the image prepared in advance. After completion of the above steps, the inking roller 15 and the blanket cylinder 16, are brought into contact with the plate cylinder 11, and paper 17 is transported in the direction indicated by the arrow in Fig. 6 while maintaining contact with the blanket cylinder 16 to enable continuous printing.

[0044]

As described above, the printing plate material of the present embodiment allows recycling thereof by utilization of the known properties of titanium oxide photocatalyst, i.e., the property of converting hydrophobicity to hydrophilicity by irradiation with light with a wavelength having an energy higher than a band gap energy of the photocatalyst and the property of converting hydrophilicity to hydrophobicity by an electrochemical

treatment that the present inventors have found in combination, and decreases the amount of printing plate materials disposed of after their use. Therefore, the cost of printing plate materials can be decreased to a greater extent. Since writing an image to printing plate materials can be practiced from the digital data on the image directly by light (ultraviolet rays), adaptation to the digitization of the printing process is achieved so that reduction in time and saving costs can be made to a greater extent accordingly.

[0045]

Since reconversion of printing plate materials and practice of renewal of the coat layer 3 can be performed in a printing machine, speeding up of the printing operation can be realized. In the above examples, writing of images to the surface of the coat layer 3 was performed in a printing machine and therefore operation can be practiced more speedily.

[0046]

[Effects of the Invention]

As explained above, according to the printing plate material as recited in claim 1, in the coat layer surface, utilization of the portions which have become hydrophilic as a non-printing image portion by irradiation of light and the remaining hydrophobic portion as a printing image portion allows the function as a printing plate to be exhibited. Also, by subjecting the abovementioned layer surface to light irradiation thereon and/or an electrochemical treatment thereon, the hydrophilic part can be converted to become hydrophobic. Accordingly, the printing plate material according to the present invention, is one which can be recycled or used repeatedly, and there is no need for disposal upon completion of printing, which is the case with conventional printing plate materials, thus related costs can be reduced.

[0047]

With the printing plate material as recited in claim 2, the surface of the coat layer has hydrophobicity in terms of a water contact angle of at least 50° or more in its initial state; thus, it is preferable as an image part.

[0048]

With the printing plate material as recited in claim 3, it is preferable to use in the printing plate material the hydrophilic surface having a water contact angle of 10° or less by irradiation with light having a wavelength at an energy level higher than a band gap energy level of the titanium oxide photocatalyst as a non-image portion. Moreover, it

goes without saying that the light irradiation spoken of here is for one operation and work which is equivalent to light irradiation related to the conversion into hydrophilicity spoken of in claim 1. Furthermore, the irradiation of light may be performed based on digital data corresponding to an image to be printed; thus, the printing plate material according to the present invention is one which accommodates digitalized printing processes, therefore achieving greatly shortened printing time and reduced costs.

[0049]

The printing plate material as recited in claim 4 is constituted such that the surface of said coat layer being hydrophilic in at least one portion thereof is reconverted into a hydrophobic surface having a water contact angle of at least 50° or more by light irradiation thereon and/or carrying out an electrochemical treatment thereon. Therefore, the printing plate material of claim 4 can obtain effects of claim 1.

[0050]

Concerning the printing plate material as recited in claim 5, too, it is clear that the same effects as those mentioned above are attained. Furthermore, according to the method for renewing a printing plate material as recited in claim 6, the abovementioned effects attained from recycling plate material, that is, the achievement of cost reduction effects and the like, especially go without saying.

[0051]

Finally, with the method for preparing and renewing a printing plate material as recited in claim 7, preparation and renewal related to the printing plate material recited in claims 1 to 5 are performed in a printing machine; thus, continuous printing operations can be implemented without being sandwiched by work for exchanging the printing plates and the like. Accordingly, continuous printing operations can be implemented and printing operations can be made more rapid.

[Brief Description of the Drawings]

[Fig. 1] Fig. 1 is a cross-sectional view showing the construction of a printing plate material. This figure also indicates the state in which the surface of the coat layer is hydrophobic.

[Fig. 2] Fig. 2 is a cross-sectional view showing a printing plate material of which a surface of the coat layer is hydrophilic.

[Fig. 3] Fig. 3 is an illustrative diagram illustrating the conversion from hydrophobicity to hydrophilicity in a titanium oxide photocatalyst.

[Fig. 4] Fig. 4 is a perspective view showing an example of an image made on a surface of the coat layer (printing image portion) and its background (non-printing image portion).

[Fig. 5] Fig. 5 is a graph illustrating the state of conversion from hydrophobicity to hydrophilicity and the state of reconversion from hydrophilicity to hydrophobicity of a surface of the coat layer with the passage of time (or the progress of the operational procedure).

[Fig. 6] Fig. 6 is an illustrative diagram illustrating an example of the construction of a printing machine.

[Brief Description of the Reference Symbols]

1	substrate
2	intermediate layer
3	coat layer
10	printing machine
11	plate cylinder
12	cleaning apparatus
13	electrochemical treating apparatus
131	transparent electrode
132	electrolyte solution
133	solution supply nozzle
134	power source
14	writing apparatus
15	inking roller
16	blanket cylinder
17	paper

[Document Type] Abstract

[Abstract]

[Problems to be Solved by the Invention] To provide a printing plate material which can be adapted to digitization of printing processes and recycled, and methods for producing and renewing the printing plate material.

[Means for Solving the Problems] As the printing plate material, there can be used one which includes a substrate on the surface of which a coat layer containing a titanium oxide photocatalyst is formed. In an initial state of the printing plate as prepared, adjustment is made to a state where the surface of the coat layer is hydrophobic. This surface is irradiated with ultraviolet rays having a wavelength at an energy level higher than a band gap energy of a titanium oxide catalyst to convert a part of the surface into a hydrophilic surface. This conversion is performed based on digital data corresponding to an image to be printed. In this case, the hydrophobic portion is used as a printing image portion and the hydrophilic portion is used as a non-printing image portion. After completion of the printing, the compound is applied again to change the surface of the coat layer into the initial state of the printing plate as prepared, in which the surface of the coat layer exhibits hydrophobicity again.

[Elected Drawing] Figure 5

Fig. 1

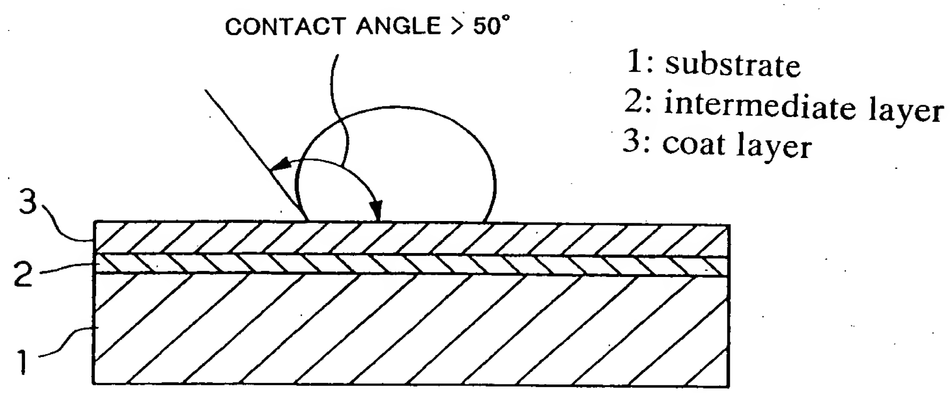

CONTACT ANGLE > 50°
1: substrate
2: intermediate layer
3: coat layer
3
2
1

Fig. 2

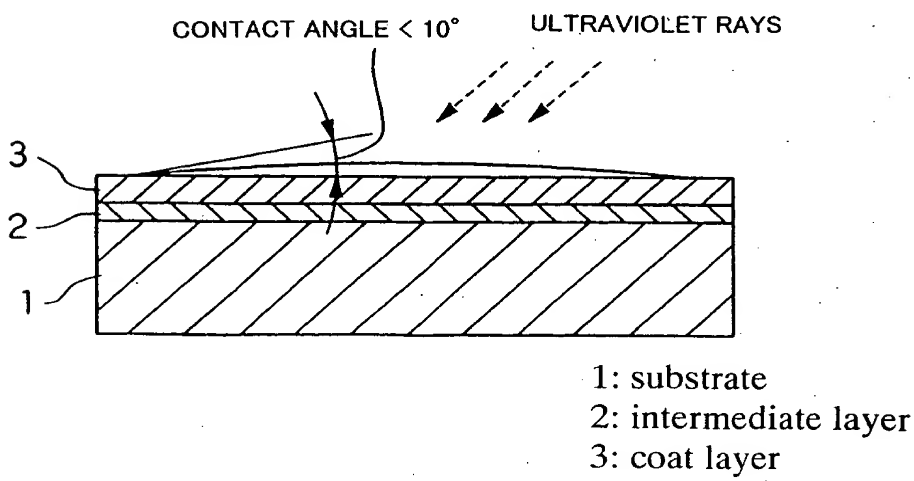

CONTACT ANGLE < 10°
ULTRAVIOLET RAYS
3
2
1
1: substrate
2: intermediate layer
3: coat layer

Fig. 3

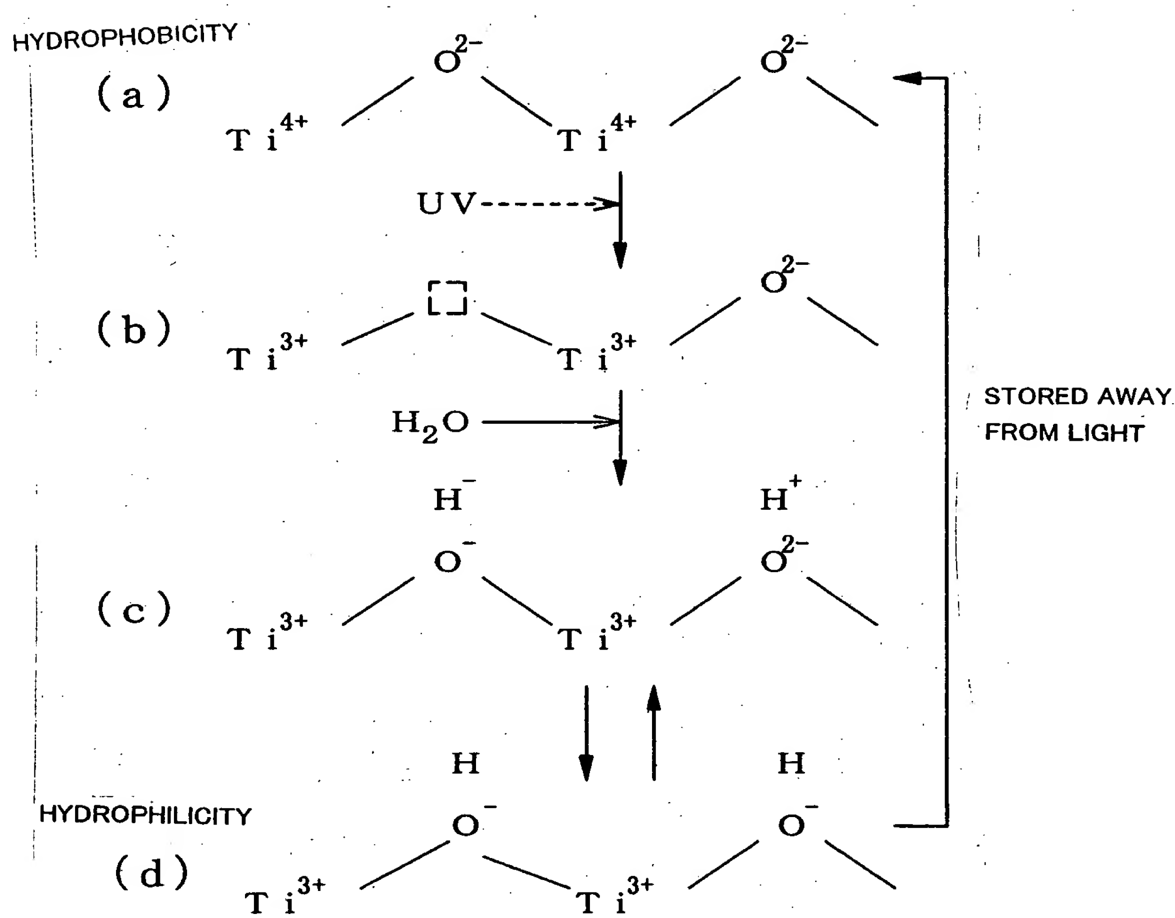
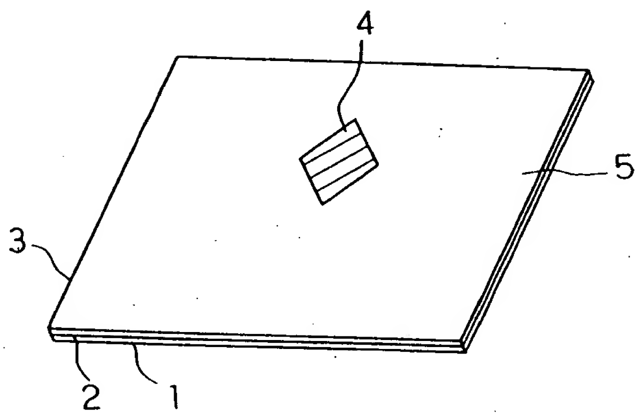

HYDROPHOBICITY
(a)
O^{2-}
O^{2-}
Ti^{4+}
Ti^{4+}
UV
(b)
O^{2-}
Ti^{3+}
Ti^{3+}
H_2O
H^-
H^+
O^-
O^{2-}
(c)
Ti^{3+}
Ti^{3+}
STORED AWAY FROM LIGHT
H
H
HYDROPHILICITY
O^-
O^-
(d)
Ti^{3+}
Ti^{3+}

Fig. 4



1: substrate
2: intermediate layer
3: coat layer
4: image part
5: non-image part

Fig. 5

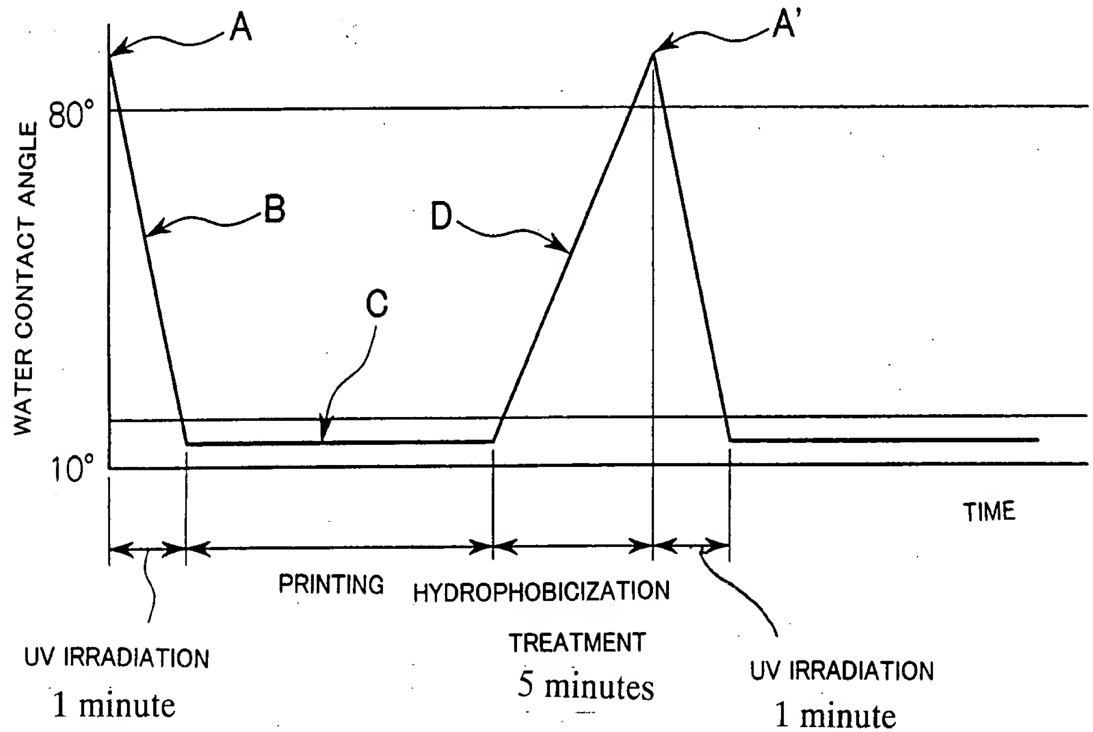
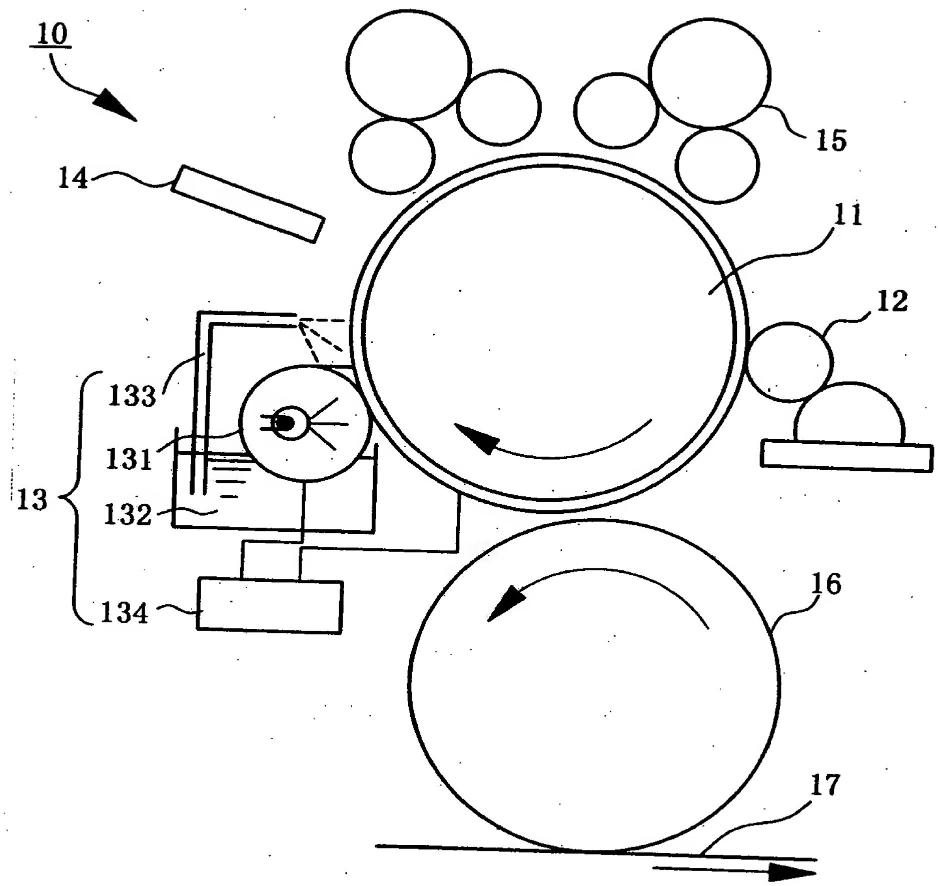

A
A'
80°
WATER CONTACT ANGLE
B
D
C
10°
TIME
PRINTING
HYDROPHOBICIZATION
TREATMENT
5 minutes
UV IRRADIATION
1 minute
UV IRRADIATION
1 minute

Fig. 6



10: printing machine
11: plate cylinder
12: plate cleaning apparatus
13: electrochemical treating apparatus
131: transparent electrode provided with ultraviolet light source
132: electrolyte solution
133: electrolyte solution supply nozzle
134: power source
14: writing apparatus
15: inking roller
16: drying apparatus
17: paper